SAMPLE PAPER - 9

Class 11 - Physics

Time Allowed: 3 hours **Maximum Marks: 70**

General Instructions:

1. There are 35 questions in all. All questions are compulsory.
2. This question paper has five sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.
3. Section A contains eighteen MCQ of 1 mark each, Section B contains seven questions of two marks each, Section C contains five questions of three marks each, section D contains three long questions of five marks each and Section E contains two case study based questions of 4 marks each.
4. There is no overall choice. However, an internal choice has been provided in section B, C, D and E. You have to attempt only one of the choices in such questions.
5. Use of calculators is not allowed.

Section A

1. If the dimensions of length are expressed as $P^x c^y h^z$; where P, c and h are the pressure, speed of light and Planck's constant respectively, then **[1]**

a) $x = \frac{1}{2}, y = \frac{3}{2}, z = \frac{-1}{2}$
b) $x = \frac{1}{2}, y = \frac{3}{2}, z = \frac{1}{2}$
c) $x = \frac{-1}{2}, y = \frac{1}{2}, z = \frac{1}{2}$
d) $x = \frac{-1}{4}, y = \frac{1}{4}, z = \frac{1}{4}$

2. A spherical ball of mass 20 kg is stationary at the top of a hill of height 100 m. It rolls down a smooth surface to the ground, then climbs up another hill of height 30 m and finally rolls down to a horizontal base at a height of 20 m, above the ground. The velocity attained by the ball is: **[1]**

a) 30 m/s
b) 40 m/s
c) 20 m/s
d) 10 m/s

3. Two discs of same moment of inertia are rotating about their regular axis passing through centre and perpendicular to the plane of disc with angular velocities ω_1 and ω_2. They are brought into contact face to face coinciding the axis of rotation. The expression for loss of energy during this process is **[1]**

a) $\frac{1}{8}(\omega_1 - \omega_2)^2$
b) $\frac{1}{4}I(\omega_1 - \omega_2)^2$
c) $\frac{1}{2}I(\omega_1 + \omega_2)^2$
d) $I(\omega_1 - \omega_2)^2$

4. Two wires A and B have the same length and area of cross-section. But Young's modulus of A is two times the Young's modulus of B. Then the ratio of force constant of A to that of B is: **[1]**

a) $\sqrt{2}$
b) 1
c) $\frac{1}{2}$
d) 2

5. A rocket has to be launched from earth in such a way that it never returns. If E is the minimum energy delivered by the rocket launcher, what should be the minimum energy that the launcher should have, if the same rocket is to be launched from the surface of the moon? Assume that the density of the earth and the moon are equal and that the earth's volume is 64 times the volume of the moon. [1]

a) $\frac{E}{16}$
b) $\frac{E}{64}$
c) $\frac{E}{32}$
d) $\frac{E}{4}$

6. An inflated rubber balloon contains one mole of an ideal gas which has a pressure P, volume V and temperature T. If the temperature rises to 1.1 T and the volume is increased to 1.05 V, the final pressure will be : [1]

a) between P and 1.1P
b) P
c) 1.1 P
d) less than P

7. The internal energy of n_1 moles of hydrogen at temperature T is equal to the internal energy of n_2 mole of helium at temperature 2T. Then the ratio $\frac{n_1}{n_2}$ is: [1]

a) $\frac{2}{3}$
b) $\frac{6}{5}$
c) $\frac{3}{5}$
d) $\frac{3}{7}$

8. In the equation $y = 4\cos(2\pi x/50)\sin 100\pi t, y$ represents the displacement of a particle at the distance x from the origin and at the time t. Then, a node occurs at the following distance: [1]

a) 20 cm
b) $(100/2\pi)$ cm
c) 50 cm
d) 12.5 cm

9. With increase in temperature the viscosity of: [1]

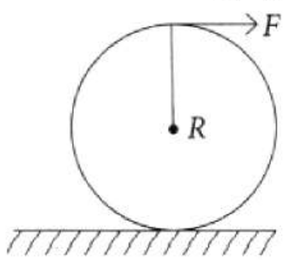
i. both gases and liquids increases
ii. both gases and liquids decreases
iii. gases increases and liquids decreases
iv. gases decreases and liquids increases

a) ii and iii
b) i and ii
c) iv and i
d) only iii

10. A particle of mass m is thrown upwards from the surface of the earth, with a velocity u. The mass and the radius of the earth are, respectively, M and R. G is gravitational constant and g is the acceleration due to gravity on the surface of the earth. The minimum value of u so that the particle does not return back to the earth is: [1]

a) $\sqrt{2gR^2}$
b) $\sqrt{\frac{2gM}{R^2}}$
c) $\sqrt{\frac{2GM}{R}}$
d) $\sqrt{\frac{2GM}{R^2}}$

11. A tangential force F acts at the top of a thin spherical shell of mass m and radius R. The acceleration of the shell, if it rolls without slipping is: [1]



a) $\frac{6}{5}\frac{F}{m}$
b) $\frac{7}{2}\frac{m}{F}$
c) $\frac{2}{7}\frac{m}{F}$
d) $\frac{5}{6}\frac{F}{m}$

12. Two vessels separately contain two ideal gases A and B at the same temperature, the pressure of A being twice that of B. Under such conditions, the density of A is found to be 1.5 times the density of B. The ratio of molecular weights of A and B is **[1]**

a) $\frac{2}{3}$
b) $\frac{1}{2}$
c) 2
d) $\frac{3}{4}$

13. Which of the following statement is correct? **[1]**

i. A stationary wave appears to be stationary but the transfer of energy from one particle to another continues to take place
ii. If a transverse stationary wave of frequency n is formed in a medium, then frequency for variation of shear strain at a point will be equal to 2n
iii. The magnitude of strain is maximum at antinode because medium particles at antinodes have maximum possible velocity
iv. None of these

a) i and ii
b) iii and iv
c) ii and iii
d) only iv

14. The coefficient of performance of a refrigerator, if it is to maintain eatables kept inside at 7°C and the room temperature is 38°C, is: **[1]**

a) 9.03
b) 16.3
c) 20.1
d) 15.5

15. Average distance of the earth frorn the sun is L_1. If one year of the earth = D days, one year of another planet whose average distance from the sun is L_2 will be: **[1]**

a) $D\left(\frac{L_2}{L_1}\right)^{\frac{1}{2}}$ days
b) $D\left(\frac{L_2}{L_1}\right)^{\frac{2}{3}}$
c) $D\left(\frac{L_2}{L_1}\right)^{\frac{3}{2}}$ days
d) $D\left(\frac{L_2}{L_1}\right)$

16. **Assertion (A):** A body X is thrown vertically upwards with an initial speed 45 m/s. Another body Y is also thrown vertically upwards with an initial speed 27 m/s. During the last $\frac{1}{2}$ sec of motion of each body, speed of each reduces by the same value. **[1]**

Reason (R): Both bodies are moving with same acceleration.

a) Both A and R are true and R is the correct explanation of A.
b) Both A and R are true but R is not the correct explanation of A.
c) A is true but R is false.
d) A is false but R is true.

17. **Assertion:** If the volume of a body remains unchanged, when subjected to tensile strain, the value of Poisson's ratio is $-\frac{1}{2}$. **[1]**

Reason: Phosphor bronze has low Young's modulus and higher rigidity modulus.

a) Assertion and reason both are correct statements and reason is correct explanation
b) Assertion and reason both are correct statements but reason is not correct

for assertion.

explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

18. **Assertion (A):** 1.37 + 4.0 = 5.37 is correct scientifically. **[1]**

Reason (R): In addition, result is true upto minimum number of decimal places in any of the numbers involved.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

Section B

19. Compute the following with regards to significant figures. **[2]**

i. 4.6×0.128

ii. $\frac{0.9995 \times 1.53}{1.592}$

iii. 876 + 0.4382

20. What do you mean by inertia of motion? Give an example to illustrate it. **[2]**

21. Two heavy spheres each of mass 100 kg and radius 0.10 m are placed 1.0 m apart on a horizontal table. What is the gravitational force and potential at the midpoint of the line joining the centres of the spheres? Is an object placed at that point in equilibrium? If so, is the equilibrium stable or unstable? **[2]**

OR

How far from earth must a body be along a line towards the sun so that the sun's gravitational pull on it balances that of the earth. Distance between sun and earth's centre is 1.5×10^{10} km. Mass of sun is 3.24×10^{5} times mass of earth.

22. Calculate the pressure required to stop the increase in volume of a copper block when it is heated from 50° to 70°C. Coefficient of linear expansion of copper = $8.0 \times 10^{-6}\ ^{o}C^{-1}$ and bulk modulus of elasticity = 3.6×10^{11} Nm^{-2}. **[2]**

23. Show that pressure exerted by a gas is $\frac{2}{3}$rd of the kinetic energy of gas molecules per unit volume. **[2]**

OR

On the basis of kinetic theory of gases, explain how does a gas exert pressure.

24. A particle is thrown upwards. It attains a height (h) after 5 seconds and again after 9s when it comes back. What is the speed of the particle at a height h? **[2]**

25. A bus starts from rest accelerating uniformly with 4 ms^{-2}. At t = 10 s, a stone is dropped out of a window of the bus 2 m high. What are the (i) magnitude of velocity and (ii) acceleration of the stone at 10.2 s? Take g = 10 ms^{-2}. **[2]**

Section C

26. Two cylinders A and B of equal capacity are connected to each other via a stopcock. A contains a gas at standard temperature and pressure. B is completely evacuated. The entire system is thermally insulated. The stopcock is suddenly opened. Answer the following: **[3]**

i. What is the final pressure of the gas in A and B?

ii. What is the change in internal energy of the gas?

iii. What is the change in the temperature of the gas?

iv. Do the intermediate states of the system (before settling to the final equilibrium state) lie on its P-V-T surface?

27. Obtain an expression for the centripetal force required to make a body of mass m moving with a speed v around a circular path of radius r. **[3]**

28. Briefly discuss how Pascal's law is affected by gravity. Hence obtain Pascal's law of transmission of pressure. **[3]**

OR

If a drop of liquid breaks into smaller droplets, it results in lowering of temperature of the droplets. Let a drop of radius R, break into N small droplets each of radius r. Estimate the drop in temperature.

29. The earth has a radius of 6400 km. The inner core of 1000 km radius is solid. Outside it, there is a region from 1000 km to a radius of 3500 km which is in molten state. Then again from 3500 km to 6400 km the earth is solid. Only longitudinal (P) waves can travel inside a liquid. Assume that the P wave has a speed of 8 km/second in solid parts and of 5 km/second in liquid parts of the earth. An earthquake occurs at some place close to the surface of the earth. Calculate the time after which it will be recorded in a seismometer at a diametrically opposite point on the earth if wave travels along diameter. **[3]**

OR

Use the formula $v = \sqrt{\frac{\gamma P}{\rho}}$ to explain why the speed of sound in air

a. is independent of pressure,
b. increases with temperature,
c. increases with humidity.

30. A 'thermacole' icebox is a cheap and efficient method for storing small quantities of cooked food in summer in particular. A cubical icebox of side 30 cm has a thickness of 5.0 cm. If 4.0 kg of ice is put in the box, estimate the amount of ice remaining after 6 h. The outside temperature is 45 °C, and co-efficient of thermal conductivity of thermacole is 0.01 J $s^{-1}m^{-1}K^{-1}$. [Latent heat of melting of ice $= 335 \times 10^3 J kg^{-1}$] **[3]**

Section D

31. A body of mass *m* is attached to one end of a massless string which is suspended vertically from a fixed point. The mass is held in hand so that the spring is neither stretched nor compressed. Suddenly the support of the hand is removed. The lowest position attained by the mass during oscillation is 4cm below the point, where it was held in hand. **[5]**

i. What is the amplitude of oscillation?
ii. Find the frequency of oscillation?

OR

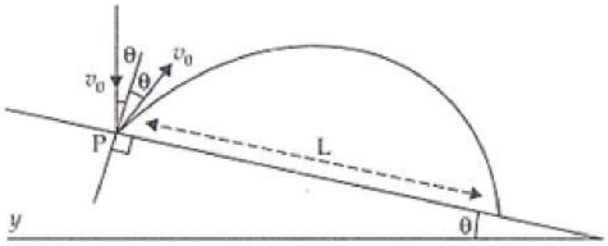
Cylindrical piece of cork of density of base area *A* and height *h* floats in a liquid of density ρ_l. The cork is depressed slightly and then released. Show that the cork oscillates up and down simple harmonically with a period $T = 2\pi\sqrt{\frac{h\rho}{\rho_l g}}$ Where ρ is the density of cork. (Ignore damping due to viscosity of the liquid).

32. A particle starts from the origin at t = 0 s with a velocity of $10.0\hat{j}\,m/s$ and moves in the x-y plane with a constant acceleration of $(8.0\hat{i} + 2.0\hat{j})ms^{-2}$. **[5]**

a. At what time is the x-coordinate of the particle 16 m? What is the y-coordinate of the particle at that time?
b. What is the speed of the particle at the time?

OR

A particle falling vertically from a height hits a plane surface inclined to horizontal at an angle with speed v_0 and rebounds elastically as shown in the figure. Find the distance along the plane where it will hit the second time.



Hint:

i. After rebound, particle still has speed V_0 to start.

ii. Work out angle particle speed has with horizontal after it rebounds.

iii. Rest is similar to if particle is projected up the incline.]

33. From a uniform disk of radius R, a circular hole of radius $\frac{R}{2}$ is cut out. The centre of the hole is at $\frac{R}{2}$ from the centre of the original disc. Locate the centre of gravity of the resulting flat body. **[5]**

OR

A solid cylinder rolls up an inclined plane of angle of inclination 30°. At the bottom of the inclined plane the centre of mass of the cylinder has a speed of 5 m/s.

a. How far will the cylinder go up the plane?

b. How long will it take to return to the bottom?

Section E

34. **Read the text carefully and answer the questions:** **[4]**

2 friends started for a picnic spot, in two different cars. A drove his car at a constant velocity 60 km/h. B drove his car at a constant velocity 50 km/h.

The velocity of B relative to A is v_B- v_A

Similarly, the velocity of object A relative to object B is v_A-v_B

Their friend C was supposed to wait at a point on the road for a lift. Both of them forgot to pick up C. A and B reached the picnic spot within 2 hours and 2 hours 24 minutes respectively.

(i) What was the velocity of B relative to A?

(ii) What is the velocity of A relative to B?

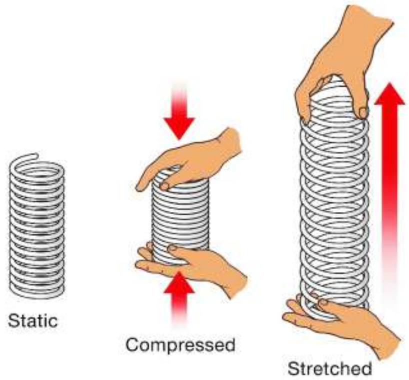
(iii) What are the velocities of A and B relative to C?

OR

Draw the Velocity vs. time plot for A?

35. **Read the text carefully and answer the questions:** **[4]**

Elastic potential energy is Potential energy stored as a result of the deformation of an elastic object, such as the stretching of a spring. It is equal to the work done to stretch the spring, which depends upon the spring constant k as well as the distance stretched



(i) If stretch in spring of force constant k is doubled, then what will be the ratio of final to initial forces?

(ii) A light body and a heavy body have the same kinetic energy. which one has greater linear momentum and why?

(iii) A spring is cut into two equal halves. How is the spring constant of each half affected?

OR

When spring is compressed, what happens to its potential energy?

Solution

SAMPLE PAPER - 9

Class 11 - Physics

Section A

1. **(d)** $x = \frac{-1}{4}$, $y = \frac{1}{4}$, $z = \frac{1}{4}$

   Explanation: Length $\propto P^x c^y h^z$

   $[L] = [M^1L^{-1}T^{-2}]^x [LT^{-1}]^y [M^1L^2T^{-1}]^z$

   By comparing the powers of M, L and T on both sides, we get, x + z = 0, -x + y + 2z = 1 and -2x - y - z = 0 which on solving give $x = \frac{1}{4}$, $y = \frac{1}{4}$, $z = \frac{1}{4}$

2. **(b)** 40 m/s

   Explanation: Loss in potential energy = gain in kinetic energy

   $mg \times 80 = \frac{1}{2}mv^2$

   $\therefore v^2 = 2 \times 10 \times 80 = 1600$

   $\therefore v = 40$ m/s

3. **(c)** $\frac{1}{2}I(\omega_1 + \omega_2)^2$

   Explanation: By conservation of angular momentum,

   $I\omega_1 + I\omega_2 = 2I\omega$

   $\Rightarrow \quad \omega = \frac{\omega_1 + \omega_2}{2}$

   Loss of K.E. = $K_i - K_f$

   $= \frac{1}{2}I\left(\omega_1^2 + \omega_2^2\right) - \frac{1}{2} \times 2I\left(\frac{\omega_1+\omega_2}{2}\right)^2$

   $= \frac{1}{2}I\left[\left(\omega_1^2 + \omega_2^2\right) - \frac{\omega_1^2+\omega_1^2+2\omega_1\omega_2}{2}\right]$

   $= \frac{1}{2}I\left[\frac{2\omega_1^2+2\omega_2^2-\omega_1^2-\omega_2^2-2\omega_1\omega_2}{2}\right]$

   $= \frac{1}{4}I(\omega_1 - \omega_2)^2$

4. **(d)** 2

   Explanation: Force constant, $K = \frac{YA}{L}$ or $K \propto Y$

   $\therefore \quad \frac{K_A}{K_B} = \frac{Y_A}{Y_B} = 2$

5. **(a)** $\frac{E}{16}$

   Explanation: Given, volume of earth (V_e) is 64 times of volume of moon (V_m), i.e.

   $\frac{V_e}{V_m} = 64 = \frac{\frac{4}{3}\pi R_e^3}{\frac{4}{3}\pi R_m^3}$

   where, R_e and R_m are the radius of earth and moon, respectively.

   Then, $\frac{R_e}{R_m} = 4$ ...(i)

   Also, since the density of moon and earth are equal, i.e. $\rho_m = \rho_e$

   $\Rightarrow \frac{M_e}{V_e} = \frac{M_m}{V_m}$, where M_e and M_m are the mass of the earth and moon, respectively.

   $\Rightarrow \quad \frac{M_e}{M_m} = \frac{V_e}{V_m} = 64$ ...(ii)

   The minimum energy or escape energy delivered by the rocket launcher, so that the rocket never returns to earth is $E_e = \frac{GM_e m}{R_e} = E$

   where, m is the mass of the rocket

   Similarly, minimum energy that a launcher should have to escape or to never return, if rocket is launched from surface of the moon is $E_m = \frac{GM_m m}{R_m}$

   $\therefore$ Ratio of escape energies E_e and E_m is

   $\frac{E_e}{E_m} = \frac{\left(\frac{GM_e m}{R_e}\right)}{\left(\frac{GM_m m}{R_m}\right)} = \frac{M_e}{M_m} \cdot \frac{R_m}{R_e}$

$= 64 \times \frac{1}{4}$ = 16 [using Eqs. (i) and (ii)]

$\therefore \quad E_m = \frac{E_e}{16} = \frac{E}{16}$

6. **(a)** between P and 1.1P

Explanation: Using PV= nRT

or, $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

Here, $P_1 = P$, $V_1 = V$, $T_1 = T$, $T_2 = 1.1T$

and $V_2 = 1.05$ V

$\therefore P_2 = \frac{P_1V_1T_2}{V_2T_1}$

$= \frac{P \times V \times 1.1T}{1.05V \times T}$ = 1.05 P

7. **(b)** $\frac{6}{5}$

Explanation: Internal energy of n moles of an ideal gas at temperature T is given by:

U = $\frac{f}{2}$nRT [f = degree of freedom]

$U_1 = U_2$

$f_1n_1T_1 = f_2n_2T_2$

Here, f_2 = degree of freedom of He = 3

and f_1 = degree of freedom of H = 5

$\therefore \quad \frac{n_1}{n_2} = \frac{f_2T_2}{f_1T_1} = \frac{3 \times 2}{5 \times 1} = \frac{6}{5}$

8. **(d)** 12.5 cm

Explanation: 12.5 cm

9. **(d)** only iii

Explanation: With the increase in temperature, the viscosity of liquids decreases and that of gases increases.

10. **(c)** $\sqrt{\frac{2GM}{R}}$

Explanation: According to law of conservation of mechanical energy

$\frac{1}{2}mu^2 - \frac{GMm}{R}$ = 0

$u^2 = \frac{2GM}{R}$

u = $\sqrt{\frac{2GM}{R}} = \sqrt{2gR} \quad \left(\because g = \frac{GM}{R^2}\right)$

11. **(a)** $\frac{6}{5}\frac{F}{m}$

Explanation: Let be the force of friction between the shell and horizontal surface.

For translational motion,

F + f = ma ...(i)

For rotational motion,

FR -fR = Iα

= $I\frac{a}{R}$ [a = Rα for pure rolling]

F - f = $I\frac{a}{R^2}$ ...(ii)

On adding equations (i) and (ii), we get

2F = $\left(m + \frac{I}{R^2}\right)a$

= $\left(m + \frac{2}{3}m\right)$a [$\therefore I_{shell} = \frac{2}{3}mR^2$]

= $\frac{5}{3}$ma

F = $\frac{5}{6}$ma

a = $\frac{6F}{5m}$

12. **(d)** $\frac{3}{4}$

Explanation: For one mole of a gas,

PV = RT $\Rightarrow P\frac{\rho}{M} = RT$

$\therefore M = \frac{\rho RT}{P}$

For same T, $M \propto \frac{\rho}{P}$

$\therefore \frac{M_A}{M_B} = \frac{\rho_A}{\rho_B} \times \frac{P_B}{P_A}$
$= 1.5 \times \frac{1}{2} = \frac{3}{4}$

13. **(d)** only iv

Explanation: A stationary wave is formed by superposition of two travelling waves having the same amplitudes and same frequencies but travelling in opposite directions. It means the net rate of transfer of energy due to both the waves is same but this transfer takes place in opposite directions. Hence, through a section, the net rate of transfer of energy becomes equal to zero. If a transverse stationary wave of frequency n is established in a medium then the frequency of variation of relative deformation of medium will also be equal to n. The magnitude of strain is maximum at nodes not at antinodes.

14. **(a)** 9.03

Explanation: Given that T_1 = 38°C = 38 + 273 = 311 K,

T_2 = 7°C = 7 + 273 = 280 K

Then coefficient of performance of the refrigerator

$= \frac{T_2}{T_1 - T_2} = \frac{280}{311 - 280} = 9.03$

15. **(c)** $D\left(\frac{L_2}{L_1}\right)^{\frac{3}{2}}$ days

Explanation: According to Kepler's law of periods,

$T^2 \propto r^3 \Rightarrow T \propto r^{\frac{3}{2}}$

$\frac{D}{D} = \left(\frac{L_2}{4}\right)^{\frac{3}{2}}$

$\Rightarrow D' = D\left(\frac{L_2}{L_1}\right)^{\frac{3}{2}}$ days

16. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation: Both A and R are true and R is the correct explanation of A.

17. **(c)** Assertion is correct statement but reason is wrong statement.

Explanation: Let Δr and Δl be the change in radius and length of the wire.

$\therefore$ Change in volume $= \pi r^2 l - \pi(r - \Delta r)^2(l + \Delta l)$

$= \pi r^2 l - \pi\left(r^2 + \Delta r^2 - 2r\Delta r\right)(l + \Delta l)$

$\Delta V = \pi r^2 l - \pi r^2 l - \pi r^2 \Delta l - 2\pi r \Delta r l$

(neglecting terms containing Δr^2 and $\Delta r \Delta l$)

Now, ΔV = 0 (given)

$\therefore \quad 2\pi r \Delta r l = \pi r^2 \Delta l$

or $\frac{\Delta r l}{r \Delta l} = \frac{1}{2}$

poisson's ratio $= \frac{\text{Lateral strain}}{\text{Longitudinal strain}} = -\frac{\Delta r/r}{\Delta l/l} = -\frac{1}{2}$

Thus, statement A is correct. But statement B is wrong because Phosphor bronze has high Young's modulus and low rigidity modulus.

18. **(d)** A is false but R is true.

Explanation: As per the rule of rounding off the numbers, result is true up to minimum number of decimal places. If the digit to be dropped is more than 5, than the predating digit is raised by one. Therefore, the more scientific way to write 5.37 is 5.4.

Section B

19.
i. Here, We have

4.6×0.128 = 0.5888 = 0.59

The obtained result has been rounded off to have two significant digits (as in 4.6)

ii. Here, we have

$\frac{0.9995 \times 1.53}{1.592}$ = 0.96057 = 0.961

The above result has been rounded off to three significant digits (as in 1.53).

iii. Here, we have

876 + 0.4382 = 876.4382 = 876

Since there is no decimal point in 876, therefore, the above result of addition has been rounded off to no decimal point.

20. Inertia of motion is the tendency of a body to maintain its state of uniform motion. As an illustration, we observe that a person jumping out of a running train or bus falls with his head in forward direction due to the inertia of motion. Similarly, passengers

experience a forward push when the driver of a bus running at high speed suddenly applies brakes.

21. Gravitational potential at the midpoint of the line joining the centres of the two spheres is

$V = \frac{GM}{\frac{r}{2}} - \frac{GM}{\frac{r}{2}} = \frac{4GM}{r}$

$V = \frac{4 \times 6.67 \times 10^{-11} \times 100}{0.1}$

= -2.68 $\times$ 10^{-7} J/kg

As the effective force on the body placed at mid-point is zero, so the body is in equilibrium. If the body is displaced a little towards either mass body from its equilibrium position, it will not return back to its initial position of equilibrium. Hence, the body is in an unstable equilibrium.

OR

Let P be a point at distance x where the gravitational pull due to the earth and the sun balance.

Then $\frac{\mathrm{GM_E m}}{x^2} = \frac{\mathrm{GM_S} m}{(r-x)^2}$

or $\frac{(r-x)^2}{x^2} = \frac{M_S}{M_E}$ = 3.24 $\times$ 10^5

or $\frac{r-x}{x} = \sqrt{3.24 \times 10^5}$ = 570

or x = $\frac{r}{571} = \frac{1.5 \times 10^{10}}{571}$ = 2.63 $\times$ 10^7 km

22. When a block of volume V is heated through a temperature of ΔT, the change in volume is

$\Delta V = \gamma V \Delta T$

where $\gamma(= 3\alpha)$ is the coefficient of cubical expansion.

$\therefore$ Volume strain = $\frac{\Delta V}{V} = \gamma \Delta T$

Bulk modulus, $\kappa = \frac{p}{\Delta V/V} = \frac{p}{\gamma \Delta T}$

Pressure, p = $\kappa \gamma \Delta T$

Here κ = 3.6 $\times$ 10^{11} $\mathrm{Nm^{-2}}$, $\gamma = 3\alpha$ = 3 $\times$ 8.0 $\times$ 10^{-6} = 24 $\times$ 10^{-6} $^{o}C^{-1}$, ΔT = 70 - 50 = 20^{o} C

$\therefore$ p = 3.6 $\times$ 10^{11} $\times$ 24 $\times$ 10^{-6} $\times$ 20

= 1.728 $\times$ 10^8 $\mathrm{Nm^{-2}}$

23. As per the kinetic theory, the pressure exerted by a gas is given by

$P = \frac{1}{3V} mn\bar{v}^2$ ..(i)

Here, m = mass of a molecule, n = number of molecules and v = rms velocity of gas moleules, V = volume of gas

Multiplying and dividing by 2 in eq(i), we get,

PV = $\frac{2}{3} n \left(\frac{1}{2} m\bar{v}^2\right)$

Mean kinetic energy of a gas molecule is $\frac{1}{2} m\bar{v}^2$.

$\therefore$ PV = $\frac{2}{3}$ $\times$ Average Kinetic Energy of n Molecules

$\Rightarrow$ P = $\frac{2}{3}$ $\times$ Average kinetic energy of n molecules per unit volume

Thus, the pressure exerted by a gas is $\frac{2}{3}$rd of its kinetic energy of n molecules per unit volume.

OR

According to kinetic theory, the molecules of a gas are in a state of continuous random motion. They collide with one another and also with the walls of the vessel.

Whenever a molecule collides with the wall, it returns with a changed momentum and an equal momentum is transferred to the wall.

24. Let total height from ground is H at t = 5s object is at a height h.

Let velocity at h is u.

velocity at top is zero.

Using equation v = u + at during upward motion

$0 = u - gt_{up} \Rightarrow t_{up} = \frac{u}{g}$

For downward motion from top to height h

$u = 0 + gt_{down} \Rightarrow t_{down} = \frac{u}{g}$

$t_{up} + t_{down} = 4s$

$\frac{2u}{g} = 4 \Rightarrow u = 19.6\mathrm{m/s}$

25. i. Horizontal velocity of the bus or the stone at t = 10 s is

v_x = u + at = 0 + 4 $\times$ 10 = 40 $\mathrm{ms^{-1}}$

Horizontal velocity will be same at t = 10.2 s because it is not affected by g.

For vertical motion of the stone,

u = 0, a = g = 10 ms^{-2}, t =10.2 - 10 = 0.2 s

$\therefore v_y = 0 + 10 \times 0.2 = 2$ ms^{-1}

Magnitude of the resultant velocity of the stone is

$v = \sqrt{v_x^2 + v_y^2} = \sqrt{40^2 + 2^2} = \sqrt{1604}$ = 40.04 ms^{-1}.

ii. After the stone is dropped, its acceleration along the horizontal is zero. It has only a vertical acceleration of 10 ms^{-2}.

Section C

26. i. Since the final temperature and initial temperature remain the same.

$\therefore P_2V_2 = P_1V_1$

But P_1 = 1 atm, V_1 = V, V_2 = 2V and P_2 = ?

$\therefore P_2 = \frac{P_1V_1}{V_2} = \frac{1 \times V}{2V}$ = 0.5 atm

ii. Since the temperature of the system remains unchanged, the change in internal energy is zero.

iii. The system being thermally insulated, there is no change in temperature (because of free expansion)

iv. The expansion is a free expansion. Therefore, the intermediate states are non-equilibrium states and the gas equation is not satisfied in these states. As a result, the gas can not return to an equilibrium state which lies on the P-V-T surface.

27. In order to maintain uniform circular motion of a particle, a force is needed because uniform circular motion is an accelerated motion. The force is known as the centripetal force. Thus, centripetal force is the force required in order to make an object move along a circular path with uniform speed. The force acts along the radius and is directed towards the centre of circular path. The centripetal force F acting on a particle moving uniformly in a circle may depend upon mass (m), velocity (v), and radius (r) of the circle.

We know that centripetal acceleration of a particle moving with a constant speed v along a circle of radius r is given by:

$a_c = \frac{v^2}{r}$ ....(1)

Hence, according to Newton's second law of motion, for a particle of mass m, we have

The centripetal force F = $ma_c = \frac{mv^2}{r}$ [by using equation (1)]

As v = $r\omega$, where ω is the angular velocity of the particle, then

F = $\frac{m}{r}(r\omega)^2 = mr\omega^2$

which is the required expression for the centripetal force.

28. PASCAL LAW :-

One of the most important facts about fluid pressure is that a change in pressure at one part of the liquid will be transmitted without any change to other parts. This rule is known as Pascal's law.

Take a vessel containing a liquid in the equilibrium at rest. Consider a volume element of liquid of height h. In the absence of gravity, according to Pascal's law, the pressure at the upper section A and lower section B of the volume element should be same. However, taking gravity into consideration we find the following forces acting on the said volume element:

i. Force P_1 (ΔA) acting vertically downward at the top face A,

ii. Force P_2 (ΔA) acting vertically upward at the bottom face B, and

Weight mg of the liquid in the volume element acting vertically downwards. Here, ΔA is the cross-section area of the given volume element.

For volume element to be in equilibrium net force acting on it should be zero. Therefore, we have

$P_1\triangle A + mg - P_2\triangle A = 0 \; or \; P_1\triangle A + mg = P_2\triangle A$

But m = mass of volume element = ΔA.h.ρ, where ρ = density of the liquid

$\therefore P_1\triangle A + \triangle Ah\rho g = P_2\triangle A$

$\Rightarrow P_2 = P_1 + h\rho g$

According to the above equation, if the pressure P_1 is increased in any way, the pressure P_2 must increase by exactly the same amount.

The pressure applied to any part of an enclosed liquid at rest is transmitted undiminished to every portion of the liquid as well as the walls of the container.

OR

change in temperature,$\Delta E = \sigma$ (final area - initial area) of surface

$\Delta E = ms\Delta t$,

By the law of conservation of mass, final volume = initial volume of one drop of radius R splited in N drops of radius r

$\therefore \frac{4}{3}\pi R^3 = N \cdot \frac{4}{3}\pi r^3$ or $R^3 = Nr^3$

$r = \frac{R}{(N)^{1/3}}$

$\Delta E = \sigma \Delta A = \sigma$ [area of N drops of radius r – area of big drop]

$ms\Delta t = \sigma\left[N.4\pi r^2 - 4\pi R^2\right]$

$V.\rho s\Delta t = 4\pi\sigma\left[Nr^2 - R^2\right]$

$N \cdot \left(\frac{4}{3}\pi r^3\right)\rho s\Delta t = 4\pi\sigma\left[Nr^2 - R^2\right]$

M = mass of all smaller drops

ρ = density of liquid

S = specific heat of liquid

Δt = change in temperature (C^0 or Kelvin)

$\Delta t = \frac{4\pi\sigma\times 3}{N\cdot 4\pi r^3\rho}\left[Nr^2 - R^2\right]\ (\because R^3 = Nr^3)$

$\Delta t = \frac{3\sigma}{N\rho s}\left[\frac{Nr^2}{r^3} - \frac{R^2}{r^3}\right]\left(\therefore r^3 = \frac{R^3}{N}\right)$

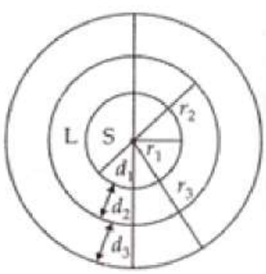
$\Delta t = \frac{3\sigma}{N\rho s}\left[\frac{N}{r} - \frac{R^2 N}{R^3}\right] = \frac{3\sigma N}{\rho N s}\left[\frac{1}{r} - \frac{1}{R}\right]$

$\Delta t = \frac{3\sigma}{\rho s}\left[\frac{1}{r} - \frac{1}{R}\right]$ as R > r

$\therefore \Delta t$ will be positive i.e., $\therefore \frac{1}{R} < \frac{1}{r}$

29. Consider the figure. Here, r_1 = 1000 km, r_2 = 3500 km, r_3 = 6400 km,

So, $d_1 = r_1$ = 1000 km, $d_2 = r_2 - r_1$ = 3500 - 1000 = 2500 km, $d_3 = r_3 - r_2$ = 6400 - 3500 = 2900 km



Solid part along diametrically,

= 2 ($d_1 + d_3$) = 2 (1000 + 2900)

= 2 × 3900 km

Time taken by wave in solid part $= \frac{3900\times 2}{8}\ sec$

Liquid part along diametrically $= 2d_2 = 2 \times 2500$

$\therefore$ Time taken by seismic wave in liquid part $= \frac{2\times 2500}{5}$ sec

Total time$= \frac{2\times 3900}{8} + \frac{2\times 2500}{5} = 2\left[\frac{3900}{8} + \frac{2500}{5}\right]$

$= 2[487.5 + 500] = 2 \times 987.5 = 1975$sec

= 32 min 55 sec

OR

a. Take the relation:

$v = \sqrt{\frac{\gamma p}{\rho}}$ ....(i)

Where,

Density, $\rho = \frac{Mass}{Volume} = \frac{M}{V}$

$\Rightarrow$ M = molecular weight of the gas

$\Rightarrow$ V = Volume of the gas

$\Rightarrow$Hence, equation(i) reduces to:

$v = \sqrt{\frac{\gamma PV}{M}}$ ...(ii)

$\Rightarrow$ Now from the ideal gas equation for n = 1:

$\Rightarrow$ PV = RT

$\Rightarrow$ For constant T, PV = Constant

$\Rightarrow$ Since both M and y are constants, v = Constant

⇒ Hence, at a constant temperature, the speed of sound in a gaseous medium is independent of the change in the pressure of the gas.

b. Now, Take the relation:

$v = \sqrt{\frac{\gamma P}{\rho}}$ ......(i)

⇒ For one mole of an ideal gas, the gas equation can be written as:

⇒ PV = RT

⇒ $P = \frac{RT}{V}$ ... (ii)

Substituting equation (ii) in equation (i), we get:

$\Rightarrow v = \sqrt{\frac{\gamma RT}{V\rho}} = \sqrt{\frac{\gamma RT}{M}}$ ....(iv)

Where,

⇒M = Vρ is a constant

⇒γ and R are also constants

⇒We conclude from equation (iv) that $v \propto \sqrt{T}$.

⇒Hence, the speed of sound in a gas is directly proportional to the square root of the temperature of the gaseous medium, i.e., the speed of the sound increases with an increase in the temperature of the gaseous medium.

c. Let v_m and v_d be the speeds of sound in moist air and dry air respectively.

Let ρ_m and ρ_d be the densities of moist air and dry air respectively.

→Take the relation:

$\Rightarrow v = \sqrt{\frac{\gamma P}{\rho}}$

⇒ Hence, the speed of sound in moist air is:

$\Rightarrow v_m = \sqrt{\frac{\gamma P}{\rho_m}}$ ....(i)

And the speed of sound in dry air is:

$\Rightarrow v_d = \sqrt{\frac{\gamma P}{\rho_d}}$ ....(ii)

⇒ On dividing equations (i) and (ii), we get:

$\Rightarrow \frac{v_m}{v_d} = \sqrt{\frac{\gamma P}{\rho_m} \times \frac{\rho_d}{\gamma P}} = \sqrt{\frac{\rho_d}{\rho_m}}$

⇒ However, the presence of water vapour reduces the density of air, i.e.,

$\rho_d < \rho_m$

$\therefore v_m > \nu_d$

Hence, the speed of sound in moist air is greater than it is in dry air. Thus, in a gaseous medium, the speed of sound increases with humidity.

30. Side of the given cubical ice box is given by, s = 30 cm = 0.3 m

Thickness of the ice box is given by, l = 5.0 cm = 0.05 m

Mass of ice kept in the ice box is given by, m = 4 kg

Time gap, t = 6 h $= 6 \times 60 \times 60s$

Outside temperature is given by, T_1= 45°C

Inside temperature, T_2 = temperature of ice = 0℃

Coefficient of thermal conductivity of thermacole is given by, K = 0.01 J $s^{-1}m^{-1}K^{-1}$

Latent heat of fusion of water is given by, $L = 335 \times 10^3 J\text{kg}^{-1}$

Let m' be the total amount of ice that melts in 6 h.

Total amount of heat lost, θ in 6 hours by the food(mathematical form of the equation comes from the definition of the thermal conductivity):

$\theta = \frac{KA(T_1 - T_2)t}{l}$

Where,

A= Total surface area of the box = 6 × Surface area of each surface of the box= $6s^2 = 6 \times (0.3)^2 = 0.54\text{m}^2$

$\therefore \theta = \frac{0.01 \times 0.54 \times (45) \times 6 \times 60 \times 60}{0.05} = 104976J$

But $\theta = m'L$, from the definition of latent heat of melting of ice.

$\therefore m' = \frac{\theta}{L}$

$= \frac{104976}{335 \times 10^3} = 0.313\text{kg}$

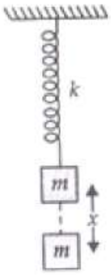
Mass of ice left is given by = Mass of ice initially kept inside the box - Mass of ice melted in 6hrs = 4 - 0.313 = 3.687 kg

Hence, the amount of ice remaining after 6 h is 3.687 kg.

Section D

31. a. Let the mass reaches at its new position x unit displacement from previous.

Then P.E. of spring or mass = gravitational P.E. lost by man



$PE = mgx$

But P.E. due to spring is $\frac{1}{2}kx^2, k = \omega^2 A$

$\therefore \frac{1}{2}kx^2 = mgx$

$x = \frac{2mg}{k}$

Mean position of spring by block will be when let extension is x_0 then

$F = +kx_0$

$F = mg \therefore mg = +kx_0$ or $x_0 = \frac{mg}{k}$ ....(ii)

From (i) and (ii)

$x = 2\left(\frac{mg}{k}\right) = 2x_0$

$x = 4\text{cm} \quad \therefore 4 = 2x_0$

$x_0 = 2\text{cm}$

The amplitude of oscillator is the maximum distance from mean position i.e., $x - x_0 = 4 - 2 = 2$ cm

b. Time Period $T = 2\pi\sqrt{\frac{m}{k}}$ which does not depend on amplitude

$\frac{2mg}{k} = x$ from (i)

$\frac{m}{k} = \frac{x}{2g} = \frac{4 \times 10^{-2}}{2 \times 9.8}$ or $\frac{k}{m} = \frac{2 \times 9.8}{4 \times 10^{-2}}$

$v = \frac{1}{2\pi}\sqrt{\frac{k}{m}} = \frac{1}{2 \times 3.144}\sqrt{\frac{2 \times 9.8}{4 \times 10^{-2}}} = \sqrt{\frac{4.9 \times 10^2}{6.28}}$

$v = \frac{10 \times 2.21}{6.28} = 3.52\text{Hz}$

Oscillator will not rise above the positive from where it was released because total extension in spring is 4 cm when released and amplitude is 2 cm. So it oscillates below the released position.

OR

This numerical can be solved using concept of Simple Harmonic Motion of floating object in which an object is dipped into the liquid and released by pushing it down,due to increased buoyant force it will move upward due to which excess force will push it downward.This repeated up and down movement of the object is governed by the laws of Simple Harmonic Motion assuming viscous forces are absent.

so area of the cork = A

Height of the cork = h

Density of the liquid = ρ_l

Density of the cork = ω

In equilibrium:

Weight of the cork = Weight of the liquid displaced by the floating cork

Let the cork be depressed slightly by x. As a result, some extra water of a certain volume is displaced. Hence, an extra up-thrust acts upward and provides the restoring force to the cork.

Up-thrust = Restoring force, F = Weight of the extra water displaced

F = –(Volume × Density × g)

Volume = Area × Distance through which the cork is depressed

Volume = Ax

$\therefore F = -A \times \rho_l g$

According to the force law:

F = kx

$k = \frac{F}{x}$

Where, k is a constant

$k = \frac{F}{x} = -A\rho_l g$ ...(ii)

The time period of the oscillations of the cork:

$T = 2\pi\sqrt{\frac{m}{k}}$ ....(iii)

Where,

m = Mass of the cork

= Volume of the cork × Density

= Base area of the cork × Height of the cork × Density of the cork

= Ahρ

Hence, the expression for the time period will be -

$T = 2\pi\sqrt{\frac{Ah\rho}{A\rho_l g}} = 2\pi\sqrt{\frac{h\rho}{\rho_l g}}$

From the above expression it is proved that time period of the fork does not depend on the mass of the object rather depends on specific gravity of the cork and height of the cork and acceleration due to gravity.

32. Given: Velocity at time t = 0 is given as

$\vec{u} = 0\hat{i} + 10\hat{j}m/s$

$\Rightarrow$ u_x = 0m/s, u_y = 10m/s

Acceleration, $\vec{a} = 8.0\hat{i} + 2.0\hat{j}m/s^2$ $\Rightarrow$ $a_x = 8.0 m/s^2$, $a_y = 2.0 m/s^2$

a. time taken by particle for x = 16 m

Using equation, $S = ut + \frac{1}{2}at^2$ along x axis

$x = u_x t + \frac{1}{2}a_x t^2$ we get

$16 = (0 \times t) + \frac{1}{2}(8)(t)^2$

t = 2s

y-coordinate at this time will be:

$y = u_y t + \frac{1}{2}a_y t^2$

$y = (10 \times 2) + \frac{1}{2}(2)(2)^2$

y = 24 m

b. Velocity along x and y-axis after time, t = 2s

$v_x = u_x + a_x t \Rightarrow v_x = 0 + (8 \times 2)$

v_x = 16m/s

$v_y = 10 + (2 \times 2)$

$v_y = 14m/s$

Net speed of the particle is:

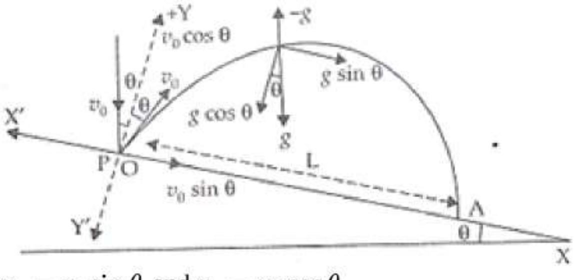
$v = \sqrt{(v_x)^2 + (v_y)^2}$

$v = \sqrt{(16)^2 + (14)^2}$

$v = 21.26m/s$

OR

From the figure resolving the components of v_0 and g, we get



$v_x = v_0 \sin\theta$ and $v_y = v_0 \cos\theta$

$g_x = gcos\theta$,$g_y = gsin\theta$ acting vertically downwards

Consider the motion of particle from O to A in new YOY' axis.

$y=u_y t+\frac{1}{2} a_y t^2$

Where, $z=0, \quad v_y=v_0 \cos \theta, \quad a_y=-g \sin \theta$

$\therefore t=T \quad$ (time of flight) , y = 0

$\Rightarrow 0=v_0 \cos \theta T-\frac{1}{2} g \sin \theta T^2$

$\Rightarrow T=\frac{2 v_0 \cos \theta}{g \cos \theta}$

$T=\frac{2 v_0}{g}$

Now consider the motion along OX axis.

$x=L, u_x=v_0 \sin \theta, a_x=g \sin \theta, t=T=\frac{2 v_0}{g}$

$x=u_x t+\frac{1}{2} a_x t^2$

$L=\left[\frac{2 v_5}{g}\right] v_0 \sin \theta+\frac{1}{2} g \sin \theta\left[\frac{2 v_0}{g}\right]^2$

$L=\frac{2 v_0^2}{g} \sin \theta+\frac{1}{2} g \sin \theta \cdot \frac{4 v_0^2}{g^2}$

$=\frac{2 v_0^2}{g}[\sin \theta+\sin \theta]=\frac{4 v_0^2}{g} sin\theta$

$\Rightarrow L=\frac{4 v_0^2}{g} \sin \theta .$

Hence the value of L is $\frac{4 v_0^2}{g} \sin \theta$.

33. The centre of mass of an object is the point at which the object can be balanced. Mathematically, it is the point at which the torques from the mass elements of an object sum to zero. The centre of mass is useful because problems can often be simplified by treating a collection of masses as one mass at their common centre of mass. The weight of the object then acts through this point.

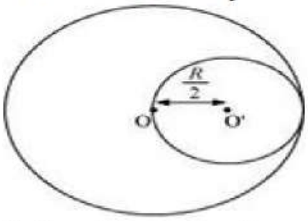
To solve this problem, first we assume that the whole disc was present whose centre of mass lies at the origin from which a small disc was cut out. So CM of remaining portion and cut out disc will lie exactly at the origin i.e Centre of Mass of the original disc at x = 0

Mass per unit area of the original disc = σ

Radius of the original disc = R

Mass of the original disc, $M=\pi R^2 \sigma$

The disc with the cut portion is shown in the following figure:



Radius of the smaller disc $=\frac{R}{2}$

Mass of the smaller disc, $M'=\pi\left(\frac{R}{2}\right)^2 \sigma=\frac{1}{4} \pi R^2 \sigma=\frac{M}{4}$

Let O and O' be the respective centers of the original disc and the disc cut off from the original. As per the definition of the centre of mass, the centre of mass of the original disc is supposed to be concentrated at O, while that of the smaller disc is supposed to be concentrated at O'.

It is given that:

$OO'=\frac{R}{2}$

After the smaller disc has been cut from the original, the remaining portion is considered to be a system of two masses. The two masses are:

M (concentrated at O), and

$\left(-M'=\frac{M}{4}\right)$ concentrated at O'

(The negative sign indicates that this portion has been removed from the original disc.)

Let x be the distance through which the centre of mass of the remaining portion shifts from point O.

The relation between the centers of masses of two masses is given as:

$x=\frac{m_1 r_1+m_2 r_2}{m_1+m_2}$

For the given system

$x=\frac{M\times 0-M\times\left(\frac{R}{2}\right)}{M+(-M')}$ (here M' is M/4)

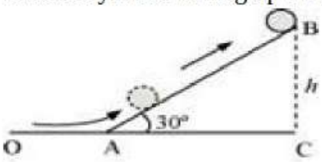
$=\frac{\frac{-M}{4}\times\frac{R}{2}}{M-\frac{M}{4}}=\frac{-MR}{8}\times\frac{4}{3M}=\frac{-R}{6}$

Note that shift in Centre of Mass is very less(only 0.16 R or $\frac{R}{6}$) as removed portion has very less mass as compared to the remaining portion.

(The negative sign indicates that the centre of mass gets shifted toward the left of point O and lies at $\frac{R}{6}$ left towards origin.)

OR

A solid cylinder rolling up an inclination is shown in the following figure.



Initial velocity of the solid cylinder, v = 5 m/s

Angle of inclination, $\theta=30^\circ$

Height reached by the cylinder = h

a. Energy of the cylinder at point A will be purely kinetic due to the rotation and translational motion. Hence, total energy at A $=KE_{rot}+KE_{trans}$

$=\frac{1}{2}I\omega^2+\frac{1}{2}mv^2$

The energy of the cylinder at point B will be purely in the form of gravitational potential energy = mgh

Using the law of conservation of energy, we can write:

$\frac{1}{2}I\omega^2+\frac{1}{2}mv^2=mgh$

Moment of inertia of the solid cylinder, $I=\frac{1}{2}mr^2$

$\therefore\frac{1}{2}\left(\frac{1}{2}mr^2\right)\omega^2+\frac{1}{2}mv^2=mgh$

$\frac{1}{4}I\omega^2+\frac{1}{2}mv^2=mgh$

But we have the relation, $v=r\omega$

$\therefore\frac{1}{4}v^2+\frac{1}{2}v^2=gh$

$\frac{3}{4}v^2=gh$

$\therefore h=\frac{3}{4}\frac{v^2}{g}$

$=\frac{3}{4}\times\frac{5\times 5}{9.8}=1.91\text{m}$

To find the distance covered along the inclined plane

In ΔABC:

$\sin\theta=\frac{BC}{AB}$

$\sin 30^\circ=\frac{h}{AB}$

$AB=\frac{1.91}{0.5}=3.82\text{m}$

Hence, the cylinder will travel 3.82 m up the inclined plane.

b. $v=\left(\frac{2gh}{1+\frac{K^2}{R^2}}\right)^{\frac{1}{2}}$

$\therefore v=\left(\frac{2gAB\sin\theta}{1+\frac{K^2}{R^2}}\right)^{\frac{1}{2}}$

For the solid cylinder, $K^2=\frac{R^2}{2}$

$\therefore v=\left(\frac{2gAB\sin\theta}{1+\frac{1}{2}}\right)^{\frac{1}{2}}$

$=\left(\frac{4}{3}gAB\sin\theta\right)^{\frac{1}{2}}$

The time taken to return to the bottom is:

$t=\frac{AB}{v}$

$=\frac{AB}{\left(\frac{4}{3}gAB\sin\theta\right)^{\frac{1}{2}}}=\left(\frac{3AB}{4g\sin\theta}\right)^{\frac{1}{2}}$

$= \left(\frac{11.46}{19.6}\right)^{\frac{1}{2}} = 0.7645$

So the total time taken by the cylinder to return to the bottom is (2×0.764)= 1.53 s.as time of ascend is equal to time of descend for the following problem.

Section E

34. **Read the text carefully and answer the questions:**

2 friends started for a picnic spot, in two different cars. A drove his car at a constant velocity 60 km/h. B drove his car at a constant velocity 50 km/h.

The velocity of B relative to A is $v_B - v_A$

Similarly, the velocity of object A relative to object B is $v_A - v_B$

Their friend C was supposed to wait at a point on the road for a lift. Both of them forgot to pick up C. A and B reached the picnic spot within 2 hours and 2 hours 24 minutes respectively.

(i) The velocity of B relative to A is

$v_B - v_A = 50 - 60$

$= -10$ km/h

(ii) The velocity of A relative to B is

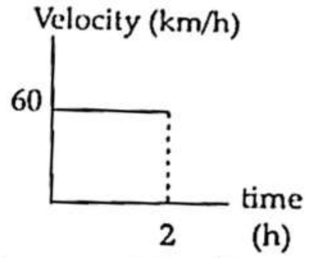
$v_A - v_B = 60 - 50 = 10$ km/h

(iii)Since C is in stationary position, his velocity was 0.

Hence the velocity of A relative to C is 60 - 0 = 60 km/h and the velocity of B relative to C is 50 - 0 = 50 km/h.

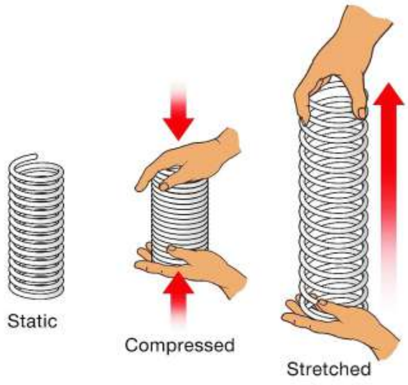
OR

Velocity time graph is as shown below



35. **Read the text carefully and answer the questions:**

Elastic potential energy is Potential energy stored as a result of the deformation of an elastic object, such as the stretching of a spring. It is equal to the work done to stretch the spring, which depends upon the spring constant k as well as the distance stretched



(i) Force required to stretch the spring by distance x is given by

F = -kx

Ratio of force on streching the spring by double distance is given by

$\frac{F_1}{F_2} = \frac{kx_1}{kx_2} = \frac{x_1}{x_2} = \frac{x}{2x} = \frac{1}{2}$

so ratio of forces will be 1 : 2.

(ii) Momentum p and kinetic energy E are related to each other as

$p = \sqrt{2mE}$

as Kinetic energy E is same for both lighter and heavy body

so $p \alpha \sqrt{2m}$

so heavy body should have large momentum.

(iii)We know that

F α l

or F = kl

therefore for a given force $k \alpha \frac{1}{l}$

so if length of spring is made half, then spring cons tan t gets double.

OR

The potential energy of spring id directly proportional to the square of compression or extension of spring therefore it increases in both the cases.